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| **Plan Title:** | **Central Resources Management** |
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# PART I - INFORMATION TECHNOLOGY ARCHITECTURE PLAN

## 1. Information Requirements

### A. Introduction

The Associate Directorate for Information Technology is responsible for providing the information technology (IT) resources needed to produce accurate, timely, and complete statistical information. Because of the rapid advancements being made in the computing industry, we must continually reexamine and redefine the mission and objectives of the Census Bureau's IT Directorate. Prior to the advent of desk-top computing (personal computers, networks, workstations, etc.) in the mid-1980's, all significant Census Bureau computing was done on large mainframe computers. The IT Directorate exclusively planned, acquired, managed, operated, and housed these systems.

As the use of personal computers became popular in the mid to late 1980's, they were initially used for office applications such as word processing and electronic mail with only limited use for survey data analysis. Production processing of census and survey data remained on our large Digital and Unisys platforms which were managed by the IT Directorate. The IT Directorate provided guidance and oversight for acquisition of desk-top devices, but the program areas were primarily responsible for managing and operating these devices.

During the past few years, the power and functionality of personal computers and workstations have soared. With these changes in power and functionality have come major differences in the ways these devices are used and, consequently, the way they must be managed. Production processing and analysis of surveys have moved partially, and, in some cases, completely to personal computers and workstations. While the IT Directorate retains primary responsibility for information technology resource management, some responsibility must be shared with program area managers in order to maximize program benefits.

The IT Directorate is challenged to manage information technology resources in an increasingly complex environment. A new paradigm is at hand demanding seamless processing across and among mainframes, minicomputers, workstations, personal computers, and local area networks. Program managers have the opportunity to reengineer the Census Bureau's business processes to dramatically improve our information products. The management of our Central Information

Technology Resources as a single entity is described in this Program Development Plan (PDP).

### B. Information Technology Planning Methodology

Central Information Technology Resources must support a host of programs which gather and report socioeconomic data needed by the Nation. Categories of support which must be provided by the Information Technology Directorate have been organized as follows:

- Central ADP Infrastructure, Maintenance, and Support
- End-User Devices Support
- Facilities Support
- Telecommunications Architecture and Support

The architecture planned for these four categories is discussed in a single Part I - Architecture Plan of this PDP but a separate Part II - Annual Plan showing detailed planning activities for fiscal years 1996, 1997, and 1998 have been prepared for each category. We envision that over the next five years, the Open Systems Technical Architecture, although currently discussed as a separate management plan, will gradually evolve into and become the Central ADP Infrastructure in the year 2001. For this reason, we will discuss these two categories as one entity throughout the remainder of this PDP. Telecommunications Support and End-User Devices Support will facilitate access by the user community to the Central Information Technology Infrastructure. Facilities Support is concerned with the physical plant and buildings required to house the Central ADP Infrastructure.

Information Technology Directorate components involved in implementing this PDP are the:

- Computer Services Division (CSvD)
- Systems Support Division (SSD)
- Telecommunications Office (TCO)
- Information Systems Support and Review Office (ISSRO)

All other Census Bureau Associate Directorates are customers who provide input, coordinate, and support the information technology planning process.

## 2. Planned Processing and Telecommunications Architecture

**Central ADP Infrastructure, Maintenance and Support**

**Current Architecture**

- ***Unisys***

We have one remaining operational Unisys mainframe computer system for Census Bureau processing at the Suitland Computer Center (SCC). This Unisys 1100/93 (D System) is used for

general work load processing. We also maintain a decommissioned Unisys 1100/93 (C System), along with some disk and tape drives, in a "warm" state at the Charlotte Computer Center (CCC) for disaster recovery. We also operate a Unisys 2200/5111 (N System) at the SCC for the National Institute of Standards and Technology (NIST) and the Economic Development Administration (EDA). This system is owned by NIST and EDA and dedicated exclusively to processing their work load. We expect NIST and EDA to migrate off of this system within three years.

The following table identifies the top nine census programs remaining on Unisys and the percentage of nondecennial work load they represent.

| Rank | Work load % | Cumulative % | Project |
|---|---|---|---|
| 1 | 43.7 | 43.7 | Demographic Surveys |
| 2 | 25.2 | 68.9 | Population |
| 3 | 7.1 | 76.0 | Management Services and Security |
| 4 | 7.0 | 83.0 | Foreign Trade |
| 5 | 4.4 | 87.4 | Economic Planning and Coordination |
| 6 | 4.3 | 91.7 | Business |
| 7 | 3.6 | 95.0 | MCD |
| 8 | 1.3 | 96.3 | Demographic Statistical Methods |
| 9 | 0.8 | 97.1 | Housing & Household Econ Statistics |

We track migration of the remaining Unisys work load to other platforms in order:

- to release the remaining economically obsolete mainframes by December 1997, and

- to identify those services currently provided only by the mainframes so that those services can be either implemented on the Digital platforms, the Corporate Unix Platform (described at the end of this section), or on other platforms to be acquired.

The Unisys systems are used primarily for:

- Large batch jobs
- Tape-intensive jobs

- Jobs requiring large sorts (e.g., >100,000 records)
- Standard batch systems that require no interactive analysis
- Large COBOL/FORTRAN jobs
- Housekeeping support (file management, and so forth)
- Jobs requiring dynamic or unpredictable disk space allocation

The Census Unisys configuration includes a front-end communications processor, 107 gigabytes (GB) of 9494 disk storage, 74 GB of 8481 disk storage, 44 cartridge tape drives, 8 magnetic tape reel drives, and two automated cartridge systems.

- Front-End Communications Processing -- A Unisys DCP 35 system provides interactive user access to the Census Bureau Unisys mainframe system. This interactive access supports on-line program development and batch process monitoring. Between the SCC and CCC, which communicate via T1 trunk lines, over 700 communication devices can access the mainframe system. These communication devices include interactive terminals, personal computers (PCs), remote printers (impact and laser) and a remote XYVISION photocomposition system used by the Administrative and Publications Services Division. We use the interactive terminals for program development, run submission, system monitoring, and training. We use the PCs for program development and data analysis.

- Cartridge Tape Subsystems--In FY 1990, we installed a new StorageTek 4780 tape cartridge handling subsystems at the SCC . This equipment continues to satisfy our requirements for mainframe tape processing. Tape cartridges are used to back-up critical files, archive historical data and electronically disseminate data to Census Bureau customers. We have allocated six of these tape subsystems to the Corporate Unix platform.

- Reel-to-reel Tape Subsystems--The need for a "reel-to-reel" magnetic tape capability for archival purposes and to accommodate transfer of non-Title 13 data in machine-readable form to the private sector is a requirement that will continue for some time.

- On-line Storage--We currently have 107 gigabytes (GB) of actual Unisys 9494 disk storage and 74 GB of 8481 disk storage. Unisys has a "virtual" mass storage system which provides the ability to over-commit disk storage. Because of this capability, our Unisys systems currently manage approximately 300 gigabytes of "on-line" user data with only 107 gigabytes of actual disk. The 107 GB of on-line 9494 disk cache storage coupled with the 74 GB of 8481 disk storage has alleviated our over-commitment of data storage resources. This storage will continue to accommodate the work load associated with several of our major surveys and allows file sharing, distribution, and transfer of data between the Unisys mainframe and Digital systems to better support multi-user functions.
- Printing--There are two Xerox 9790 on-line page printer systems which support user processing activities. Two StorageTek 5000 E-50 impact line printer units and two Unisys 0777 laser printers are used to support production printing requirements.

- ***Digital***

In the past, the DEC computers were used primarily for:

- Interactive departmental jobs
- Jobs requiring extensive statistical analysis using SAS
- Data base management jobs
- Interactive data entry and verification

The Digital computers and net-worked end-user devices are among the target environments for the work load migrating from the Unisys environment. As work load is moved to these target platforms, we must plan so that our users have the equivalent functionality that previously was only available from Unisys. At present, known shortfalls in the current Digital environment include support of tape-intensive jobs, housekeeping support including file management, and jobs requiring dynamic or unpredictable disk storage allocation.

The primary Digital processing platforms are VAX 6000 and 7000 (upgradeable to ALPHA) series equipment. Two of the three VAX 9000 systems have been removed from service and will be surplused. The remaining VAX 9000 is used for general processing work and will be surplused in FY 1997.

The Demographic Interactive Survey Analysis Resource cluster supports processing and analysis of demographic current surveys.

The Decennial Management Division (DMD) cluster supports processing for test censuses, precensus activities, software development, and management information system support for the decennial census.

Economic Statistical Methods and Programming Division (ESMPD) resources include several clusters supporting both the Agriculture and Economic Census and the Current Economic Surveys.

The Geography cluster is used for management and maintenance of the TIGER file and the Master Address File. The Suitland Professional Center (SPC) Geography system is used for software development.

The Administrative Information Management System (AIMS) cluster supports bureau-wide administrative services until the Commerce Administrative Management System (CAMS) is implemented.

The IT (general purpose) cluster provides shared support to programs that do not have dedicated resources.

The Systems Support Division test system is used to evaluate new commercial software releases before they are released for production use.

The Digital systems in Data Preparation Division in Jeffersonville are used for data entry, software development, and inventory control.

The following table identifies the top nine programs on Digital and the percentage of work load they represent.

| Rank | Work load % | Cumulative % | Project |
|---|---|---|---|
| 1 | 21 | 21 | Decennial Development Production Processing |
| 2 | 19 | 40 | Economic and Agricultural Production Processing |
| 3 | 16 | 56 | Geographic Development Processing |
| 4 | 15 | 71 | Geographic Production Processing |
| 5 | 14 | 85 | General Statistical Analysis Processing |
| 6 | 6 | 91 | Demographic Development and Production Processing |
| 7 | 3 | 94 | Economic Development Processing |
| 8 | 3 | 97 | Jeffersonville Operations Processing |
| 9 | 3 | 100 | Administrative Processing |

- ***High Performance Computing***

The goal of our High Performance Computing initiative is to provide specialized computing resources that will meet customer demands that can not be met with traditional computing architectures.

Our Unix Platform consists of Silicon Graphics Incorporated (SGI) and Convex central processing units. The SGI Challenge Series computer is configured with four processors, 512 MB of memory, 80 GB of RAID Disk, two STK 3480 tape cartridges, a 4 mm tape drive, and, it shares an STK ACS Silo with the Convex system. Besides software development tools, we provide ANSI Fortran and C languages, SAS, and Oracle.

Current work on the SGI system includes a SAS version of the Standard Statistical Establishment List (SSEL) data base; the 1993 Commodity Flow Survey and the 1997 Commodity Flow Survey; and compute intensive special studies conducted by the Statistical Research Division.

We installed a Convex C240 with 256 Mbytes of memory and four CPUs. Each CPU has a scalar processor and a vector processor. The Convex configuration has 40 GBytes disk storage, 16 STK 3480 tape drives, two 4mm tape drives, and several types of peripheral interconnects such as ethernet, STK silo, and so forth. The Convex system is used for the CENSAS project to produce ad hoc tabulations of 1990 Census data using SAS and also to back-up other Unix systems.

We conducted high-performance computing (HPC) tests applicable to the Census Bureau's business functions. Our test plan addressed seven test scenarios applicable to the Census Bureau's statistical environment. We used Convex, DEC, and SGI computing platforms to conduct the tests.

Overall, we found that test performance among vendors as initially configured was comparable. However, when we tried to change the size or scale of the configurations, we discovered that the UNIX operating system performed best. In particular, we found that the scalability of HPC platform components such as the central processing unit, system memory, and disk storage were better for the UNIX operating system.

The alternative to high-performance computing resources is increasing our general purpose data processing capability. This would limit not only our opportunities to reengineer our existing applications but also preclude automating processes that can not be supported with traditional architectures. The high-performance computing project will include evaluations of various applications of high-performance computing technologies to improve Census Bureau programs.

There are two alternatives to on-site proof-of-concept prototyping of high-performance computing. The first alternative is to abandon research and continue to attempt to support our customers with inadequate and costly technology. The second alternative is to continue research through contractor's analysis of available technologies. There are several disadvantages to this alternative:

- We have to rely on the contractor's expertise without gaining the hands-on experience and knowledge necessary to fully evaluate their recommendations,

- Paper analysis cannot fully assess the performance of actual Census Bureau applications on alternative architectures,

- Census Bureau personnel would not gain the knowledge and experience necessary to bring successful research projects through development to implementation, and,

- Research projects that require connection to current Census Bureau systems and networks could not be conducted.

**Mass Storage Strategy (MSS) Test Results**

The MSS focuses on the complex issues of storing, moving, processing, and ensuring the integrity of data across diverse processing platforms. It establishes a strategy for evaluating not only the technologies available for storing and managing data but also the customer needs for data access and integrity. Technology alternatives include robotic media handlers, hierarchical storage systems, alternative media (such as Digital Audio Tape, CD-ROM, and so forth) and, direct-access storage devices. Architectural considerations include locally attached and managed devices, network-attached devices and central computer attached devices. Most importantly, the MSS includes consideration of the various software products available to manage the data and storage architecture. We will manage these storage resources in accordance with the methodology outlined in the report entitled "Mass Storage Management Strategy" which has been endorsed by the DOC.

The current obsolete mass storage will be retired and new mass storage will be acquired in accordance with our Mass Storage Management Strategy. The strategy includes a four-level storage hierarchy (as defined by Sanjay Ranade, author of "Mass Storage Strategies"):

- rapid access (or in-line) storage
- staging (or near-line) storage
- mass storage
- off-line storage

Mass storage is only one level of a four-level hierarchy. As users develop new software systems or migrate software systems from proprietary Unisys and DEC systems, we will determine the most appropriate level and type of storage for each application. We will ensure that the migration transition platforms have a mix of storage types that minimizes total storage cost while meeting required performance levels. Storage subsystems on the Unisys system, such as STK tape cartridge silos, will be used on future OSE systems if it is cost-effective.

We recently completed an evaluation of various backup and archiving solutions which could be incorporated into our future open systems environment. In line with our mass storage strategy, we evaluated backup and archiving systems from six major vendors: IBM, Convex, EMASS, Titan, Cray Research and DEC. We found one product which best met our strategic requirements. The product was the Advanced Distributed Storage Manager (ADSM) system from IBM. While not perfectly meeting our requirements or functionalities, we confirmed with IBM that their system could be upgraded to provide those additional functionalities. In fact, the provision of those additional functionalities is consistent with IBM’s future product development direction.

We adopted a three-phase approach for implementing an Enterprise Data Backup and Archiving (EDBA) solution to replace our current storage systems. The three phases are:

- Phase 1. This phase provides a plan for the entire implementation process and explains the important milestones. This phase is completed.

- Phase 2. This phase involves prototyping which will result in the development of specifications for the EDBA system, the definition of specific software upgrades needed for the IBM ADSM system, and provide a schedule with cost estimates for implementing Phase 3.

- Phase 3. This phase consists of using a vendor to perform software upgrades, implementing the system on multiple platforms, and testing the system on those platforms. We anticipate testing on at least the following platforms: IBM, HP-UNIX, SUN, and SGI.

**Standards and Uniform Product Policy and Procedures**

The identification, selection, and implementation of standards and uniform software products are critical for our central resources management objective to successfully provide:

- A cost-effective, secure processing environment across diverse hardware, software, and telecommunications systems;

- Seamless access to our users; and

- An opportunity to dramatically change and improve the processing capabilities and the level of service.

The Standards Management Steering Committee has overseen the implementation of nine standards. Another five standards will be issued shortly. To expedite the identification and implementation of standards, the Open Systems Transition Staff in SSD contracted with a commercial systems firm to propose a standards selection methodology and recommend initial standards for adoption. Most of these standards will be implemented in the near future.

The IT Directorate, in cooperation with the program areas, has been selecting software products based on the Bureau's needs and committing specific levels of support for each product. This complements the Standards Program where the selected products are compliant with applicable functional, data interchange, or telecommunications standards. Supported products include: cc:mail, WordPerfect, SAS, Oracle, Rdb, Novell Netware, Netscape, and MS-Windows. To that end IT will procure site licenses for all selected office automation (OA) software.

Uniform Product Selection complements the Information Technology Standards Program where the products selected are compliant with any applicable functional, data interchange or

telecommunication standards issued through the Standards Program. The goal is to attain economy, efficiency and effectiveness in acquisition, support and use of commercial software products.

- *Benefits*

Reduce user area procurement burden and achieve best pricing by centralizing acquisition support and by volume purchasing.

> We can achieve leverage for either volume discounts or site licensing by combining large user base buys. Once an acquisition vehicle is established, users can draw upon it thereby eliminating lengthy procurement steps. The savings in time and effort is multiplied by the number of areas that would otherwise do an individual procurement. An explicit step in the uniform product selection process would make sure that the potential product will meet current standards (unless business case justifies otherwise)

Reduce number of personnel needed to provide essential support functions beyond acquisition and distribution. These include training, technical expertise, and help desk.

> Training resources, both in-house and contractor, can focus on a smaller set of products. Training resources can be used to increase depth of instruction rather than "introductory" training on a diverse set of products.
>
> Limiting the set of products supported will reduce the need to maintain expertise in numerous products. This will not only reduce the number of personnel needed, but also will enhance the depth of expertise in the products that are supported.
>
> By providing a central repository for reported problems and solutions IT will help reduce the Bureau-wide effort expended on problem resolution and obtaining patches and corrections. The central facility provides a point of contact for all of the users areas at the Bureau for this kind of information.

Enable development of a corporate knowledge base by establishing a central coordination point and repository for product evaluation.

> IT should provide a product evaluation and testing facility which serves as a collection point for information about a product or products that satisfy specific functionalities. This provides one place for users to locate and utilize expertise, instead of many independent evaluation efforts. This would include any assessments done on products and access to loaner evaluation copies of software. IT will make it easier for users to obtain information about products in use or under evaluation at the Bureau. A central location for collecting and sharing information about products cuts down the time needed to do research by any one area of the Bureau (one stop shopping)!

Enable development, increase value and facilitate locating of experts through concentrating on wider use of fewer products.

With a wider use of fewer products comes personnel who are a general resource to the whole Bureau. There will be more concentration of knowledge and greater available expertise because there is a focus on fewer packages with broader use. There will be increased mobility of personnel because skills learned in one area will be applicable across the bureau. Retraining costs will be reduced significantly.

Facilitate software accounting, inventory, version and upgrade management through a consistent method for distribution, tracking and administering the use of software.

Centralized acquisition and distribution of software will reduce the number of different versions of the same software in use at the same time. There will be fewer products to track. Better records can be kept on who has, uses, and needs specific software products. Different versions of the same software may create many of the same incompatibility problems experienced when using different software for the same purpose. This also provides for a more orderly and planned move from one version to the next of a given software product.

For example, in assessing the need for standard licensing of WordPerfect, IT discovered that little formal information was available concerning number of legal copies and number of versions. Repeated efforts to collect this information have yielded nothing better than best guess estimates. A managed acquisition process would allow this information to be automatically collected and made readily available. Also, this reduces the redundant effort across the BOC in acquisition activities.

Ensure product integrity by establishing accountability of product source and institute coordinated and effective communications with vendors.

By acquiring products from a centralized, coordinated contract with stated support clauses, we can increase assurance that products used in Bureau production processes have vendor accountability and will be supported in the future. We have the potential for more leverage with the vendor leading to better support due to the large combined user base. We also can keep track of vendors who have been a problem in the past.
Ideally, all employees will have the ability to call the vendor for problem resolution, but IT or a central source should maintain a clearinghouse of documented solutions. This will eliminate duplication of effort and enable knowledge sharing.

Ensure integrity of data interchange between products and enhance data interchange capabilities by deploying fewer and known, tested products.

Fewer products lead to a less complicated environment. We would be in a better position to have adequate resources to test all deployed products to make sure we can share data between products or document data interchange problems. There should be less need to write conversion programs to share data

Ensure open systems principles are followed and reinforce the IT Standards Program in acquisition and use of software for distributed systems.

By using products that have been selected with a Bureau-wide perspective we can increase assurance that they are portable, interoperable and scalable. Many of the benefits described above directly connect to open systems objectives.

## End-User Devices Support

### Current Architecture

Approximately 5800 personal computers and workstations are attached to our networks. (Note that the following charts show only our base of INTEL compatible PCs.) In the past, the end-users have been primarily responsible for specifying, acquiring, and managing these devices. Many of these devices were acquired in the late 1980s and early 1990s, have become technologically obsolete, and are incapable of supporting today's software technology. Additionally, neither hardware nor software environments are consistent across different Census Bureau divisions. As these devices are being used more for production applications and are now a target platform for some applications migrating from Unisys, our central IT management and support responsibilities have increased.

We have developed a five-year (FY 1996-FY 2000) Personal Computer Management and Acquisition Plan (PCMAP) which has been approved by the Department of Commerce (DOC). This plan integrates the planning, acquisition, policies, procedures, and management of the Census Bureau's personal computers. We currently have in place a three year contract to acquire personal computers to replace our aging installed base.

The following table shows the current Intel-based PC assets at headquarters. It does not include Macintosh and Unix systems.

| PERSONAL COMPUTER DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| PROGRAM AREA | XT | 286 | 386 | 486 | PENTIUM | TOTAL |
| DIRECTOR | 3 | 26 | 132 | 102 | 26 | 289 |

| PERSONAL COMPUTER DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| PROGRAM AREA | XT | 286 | 386 | 486 | PENTIUM | TOTAL |
| PRINCIPAL ASSOCIATE DIRECTOR AND CHIEF FINANCIAL OFFICER | | | | | | |
| ADMINISTRATION | 1 | 2 | 257 | 30 | 28 | 318 |
| INFORMATION TECHNOLOGY | 1 | 9 | 127 | 224 | 96 | 457 |
| PLANNING AND ORGANIZATION DEVELOPMENT | | 1 | 49 | 115 | 15 | 180 |
| COMPTROLLER | | 1 | 53 | 32 | | 80 |
| TOTAL | 5 | 39 | 618 | 503 | 165 | 1,330 |
| PRINCIPAL ASSOCIATE DIRECTOR FOR PROGRAMS | | | | | | |
| FIELD OPERATIONS | 37 | 105 | 870 | 687 | 210 | 1,909 |
| ECONOMIC PROGRAMS | 5 | 30 | 296 | 929 | 119 | 1,379 |
| DECENNIAL CENSUS | 1 | 31 | 116 | 68 | 155 | 371 |
| DEMOGRAPHIC PROGRAMS | 3 | 24 | 309 | 224 | 101 | 661 |
| STATISTICAL DESIGN AND METHODOLOGY | 1 | 5 | 37 | 40 | 1 | 84 |
| TOTAL | 47 | 195 | 1,628 | 1,948 | 586 | 4,404 |
| CENSUS BUREAU TOTAL | 52 | 234 | 2,246 | 2,451 | 751 | 5,734 |

The predominant software products used at the desk-top are:

| | |
|---|---|
| Graphical User Interface | MS-Windows |
| Word Processing | WordPerfect |
| Spreadsheet | |
| Lotus 1-2-3 and QuattroPro | |
| Database | dBase and Paradox |
| Network Connectivity | NetWare |
| E-mail | |
| cc:mail | |
| Calendar/Scheduler | OnTime |
| Internet Web Browser | Mosaic and NetScape |
| Statistical Package | SAS |

The focus of our central management resources objective is to deliver the most cost-efficient processing power to the individual user at the desk-top. Because we are using standard interfaces, communication software, and uniform software products, the physical device on the desk-top is a commodity and can be replaced or upgraded quickly. The user is able to access large databases and take advantage of powerful enterprise computational resources easily.

## Facilities Support

### Current

- *Suitland Computer Center (SCC)*

The SCC contains 45,663 square feet of raised floor, environmentally controlled space within Federal Building 3 (FB-3). FB-3 was constructed in 1942 as an office building. Fifty-year-old building systems are deteriorating. Bursting water pipes and a leaking roof cause almost monthly threats to the costly computer equipment. Building structural constraints prevent the facility from being upgraded to meet contemporary needs.

- *Charlotte Computer Center (CCC)*

CCC is a leased facility constructed in 1989. It contains 31,000 square feet of raised floor, environmentally controlled space. The initial purpose of the CCC was to provide a contingency processing site for the 1990 decennial census and to provide adequate space for the returning decennial census computer equipment. It is now the primary processing site for post-decennial census tabulations, Geography, and the 1992 Agriculture/Economic Census. The CCC was designed as a general purpose data processing facility.

### Alternatives

- *Retaining the Suitland Computer Center (SCC)*

In our previous plan submission, we addressed two alternatives to resolve the deteriorating conditions at the SCC. Renovation of the existing facility is the least attractive alternative because of the building's construction constraints. These construction constraints makes efficient space utilization impossible.

- *Retaining the Charlotte Computer Center (CCC)*

The CCC was constructed as a contingency site to process the 1990 decennial census. Although the CCC currently houses operational equipment, it does not provide the flexibility needed to consolidate all Census Bureau IT resources in one accessible location and also provide the

additional space needed for the 2000 decennial census. When the current CCC lease expires in December 1997, the facility will be closed.

**New Facility**

- *Constructing the Bowie Computer Center (BCC)*

The State of Maryland, on behalf of the University of Maryland, has donated a site at the Science and Technology Center in Bowie, Maryland, to the General Services Administration (GSA). The General Services Administration is building a new state-of-the-art computer facility for the Census Bureau at that site. The Bowie Computer facility will have a raised floor area of 49,800 square feet and will contain features such as fiber optic communications, uninterruptible power supplies, emergency generators, power distribution units, computerized monitoring systems, and security systems. These "above standard features" are not funded by GSA and the cost must be borne by the Census Bureau. When completed, this facility will provide state-of-the-art computer space for current needs as well as future expansion needs. The facility will be a joint effort between the Census Bureau and the University of Maryland and will benefit both organizations through the exchange of technical information and expertise.

The modernization of the Census Bureau's central computer equipment, including high-performance computing resources defined by our current prototyping activities, will become the nucleus of the Bowie Computer Center. It will also house the tape library, tape vault and other infrastructure needed to support the continually growing data processing requirements of the Census Bureau and also accommodate the increased growth requirements of the 2000 Decennial Census. In addition, the facility will allow the Census Bureau to provide reimbursable data processing services to agencies who have downsized and closed their data centers.

**Benefits**

Co-locating the new Census Bureau computer center with the University of Maryland at the Bowie site, and sharing its use with the University, will achieve long-term benefits for the Census Bureau.

- The Census Bureau will benefit from the University's expertise and experience in effective programming and use of high-performance computing, in scientific visualization, in Internet and National Information Infrastructure networking and network services.

- The new facility will accommodate growing technological needs and also support processing for the 2000 decennial census.

- The BCC can also provide data processing services to other DOC operating units that have been forced to close their data centers. We also expect additional flexibility to accrue from this consolidated data center concept.

- We have completed a report by CS Technology, Inc. entitled "U. S. Bureau of the Census Technology Migration Advance Plan" that addresses the issues associated with site readiness and equipment relocation.

- We are working with the DOC as a part of a data center consolidation team. The results should help mold our staffing requirements as well as short- to mid-term services required by outside customers of our computer facilities and resources.

## Telecommunications Architecture and Support

The business goal of the Telecommunications Office (TCO) is to provide the infrastructure necessary to support the telecommunications requirements of the Bureau of the Census Directorate programs, internal users, and external customers. Specifically, this supports the program development plan submitted by the Census Associate Directorate areas, and includes:

- Field surveys
- Internet access for external customers
- Distributed processing to enable user access to central resources
- Security to preserve data confidentiality
- Migration to open systems
- Cost effective solutions to balance needs against cost
- 99.9% network availability

### Current Architecture

The current Telecommunications architecture is shown in Figure 2. TCO has made major strides in moving the old architecture toward the planned architecture described below. Standards have been defined for hardware (e.g., routers and concentrators), software (e.g., TCP/IP, SNMP, cc:Mail), and communications (e.g., FDDI ISO9314, Frame Relay). Cabling systems, concentrators, and routers are beginning to be monitored for performance since the arrival and installation of performance monitoring tools so that a performance baseline can be established in FY 1996 for the following years. Network bottlenecks have been identified and removed by the addition of fast ethernet switches, concentrators, routers, and resegmentation of the network. These modifications have resulted in increased performance and network reliability over the past two years. The architecture migration is estimated to be 40 percent complete. An overview of the architecture status for the enterprise, WAN, LAN, and voice is found below and details on all initiatives are found in Part II, Section 3, Status.

The TCO architecture consists of three distinct functional architectures. TCO has separated the service provided to the end user for fast, seamless access to electronic resources into these three areas because the issues, concerns, media, and standards are different in each of these areas. The functional areas are:

- Enterprise - Encompasses all communications external to the Census, all Census-wide telecommunications standards, and computing resources, e.g., databases, processing power, etc., shared by all Census users. The Enterprise currently includes access to the Internet for 4000 internal Census users. Access to Census from the Internet is currently limited to data placed on the Internet Server and outside users do not cross the firewall. Access to other Government agencies is currently provided by dedicated secure lines. Dial in access is limited to Census field staff and CAPI users. Remote access is controlled by a bastion host firewall leased in 1995 under a two year lease.

  As the Open Systems Migration takes place, the IPX (from Novell LANs), LAT (from VAX servers), DECNET (from VAX clusters and servers), and Appletalk (from Macintosh PCs) networking protocols are being migrated to the TCP/IP standard.

- Wide Area Network (WAN) - Encompasses all telecommunication between geographically dispersed offices, i.e., between the enterprise and the LANs. The WAN currently includes fiber access to the Campus LAN and T-1 Frame Relay access to the Remote and Data Center LANs. As the Bowie Computing Center (BCC) comes on line, it will also be accessed via fiber SONET lines since it is part of the Campus LAN and the anticipated bandwidth requires a fiber connection. Multiple T-1 leased lines have been installed to the data centers and between the data centers to improve reliability and accessibility. A single leased line will not be guaranteed by FTS to have uptime in excess of 99.5% and the cost/benefit for access to the Enterprise Computing Resources requires a 99.9% uptime.

- Local Area Network (LAN) - Encompasses all telecommunication within a geographically dispersed office. The LAN currently includes outdated 10Base2 and 10Base5 cable plant installations at DPD in Jeffersonville. This is being replaced by Category 5 UTP which is 100 Mbps capable to bring Jeffersonville up to the same standard used at all other locations and to increase the reliability and fault isolation of the cable plant. The replacement is 100 percent complete for all other sites. As the cable plant migration takes place, the addition of concentrators and fast ethernet switches allows performance monitoring in compliance with the overall architecture.

Voice has been minimally integrated into the Enterprise and current capability allows users to be informed via voice mail how many electronic messages have not been read and by electronic mail how many voice mail messages have been received.

Within the LAN architecture, there are four basic types of LANs:

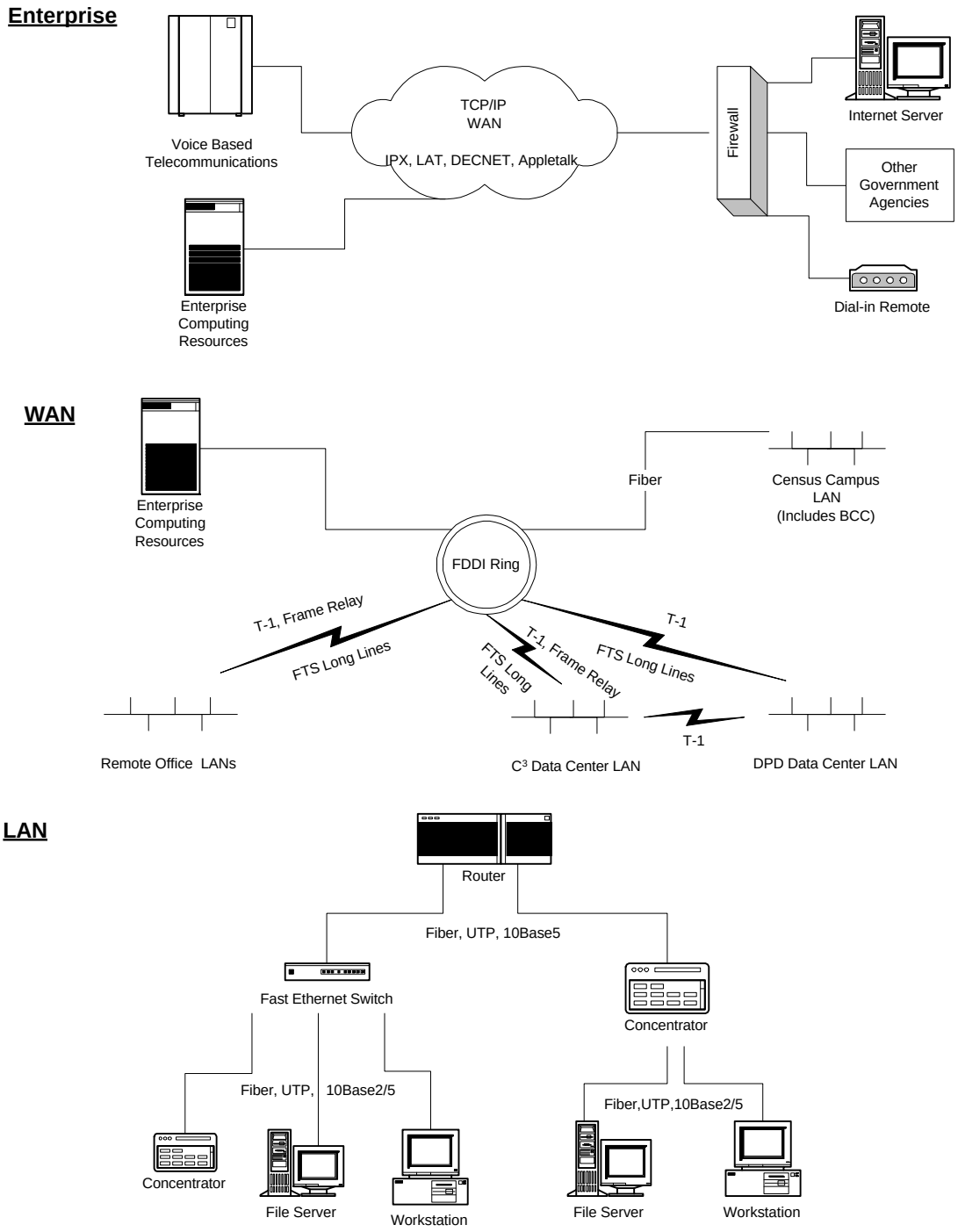



**Figure 2 Current Telecommunications Architecture**

- Remote Office - The Remote LAN consists of 80-100 users on a single floor in the same building. This includes CATI sites, Regional Offices, Regional Census Centers, and local collection offices for the Decennial Census.

- Data Center LAN - The Data Center LAN consists of Jeffersonville with 1000-2500 users on single floors within multiple buildings.

- Census Campus LAN - The Census Campus LAN consists of the Washington, DC geographical area and includes Federal Office Building (FOB) 3, FOB 4, Washington Plaza 1 and 2, SHEP, Iverson Mall, and the Bowie Computer Center. This LAN supports 4000 users.

- Virtual LAN - The virtual LAN is the logical grouping of users into a workgroup LAN based on functional requirements regardless of where the user is physically located on the LAN, e.g., a given office that has 10 people in FOB3 and 5 people in Bowie that need to share calendaring, schedules, documents, etc.

Census end user access can be traced from the workstation in any given LAN to any resource available electronically. Likewise, external resources can be traced to the resources, if they are granted the access.

TCO has made a concerted effort to begin the transition of the individual, separate resources and standards used throughout Census to the TCO architecture that embraces these three functional areas. Figure 3 visually depicts the current TCO architecture and highlights those areas that still need to be transitioned to the planned architecture and Figure 4 lists the related transition items. Figure 5 visually depicts the planned TCO architecture.

Within the Enterprise, the proprietary networking protocols of Novell (IPX), Digital Equipment Corporation (LAT, DECNET), and Apple (Appletalk) are being migrated to the de facto industry standard of Transmission Control Protocol / Internet Protocol (TCP/IP). The voice based telecommunications already has limited integration but will be more closely integrated as planned technology becomes available. The external communications provided through the firewall are expected to increase in volume while the architecture in place remains unchanged.

Within the WAN, the FTS leased lines will be replaced by a Post-FTS vendor. Frame Relay will be the protocol used over the leased lines and TCO will lease the number of lines at the speeds necessary (e.g. two T-1 1.544 Mbps lines or one T-3 45 Mbps line) to provide the throughput required. For links requiring higher speeds, e.g. to the Campus LAN, fiber lines will be leased (SONET) and the Asynchronous Transfer Mode (ATM) protocol will be used over the fiber lines. Once the Charlotte Computer Center (C3) Data Center is closed, all communication between Data Center LANs will via the FDDI ring, i.e., there will be no direct links between Data Center LANs.

Within the LAN, all 10Base 5 (thicknet) and 10Base2 (thinnet) cabling will be transitioned to fiber and category 5 unshielded twisted pair (UTP) because these two media are capable of 100 Mbps transmission speeds when the network interface cards (NICs) inside the workstation and the related board in the concentrator or router are changed to 100 Mbps capable boards.

This migration will also increase the network monitoring and troubleshooting capabilities because lines to each workstation will be able to be identified and isolated.

TCO has emphasized flexibility and scalability throughout the architecture so that they can respond to changes in throughput requirements, e.g. increased capacity demand, change in Remote Office locations, increased capacity to the workstation, etc., in a reasonable time frame with minimal cost. The Network Operations Center (NOC) will be responsible for monitoring and managing the network performance using the Simple Network Management Protocol (SNMP and SNMP-2). All current SNMP capable equipment will be transitioned to SNMP-2 as it becomes available. This capability is essential to TCO's ability to support major Census initiatives such as the Decennial Census.

TCO is upgrading all existing Merlin Key systems to Legend Hybrid Key systems. The Merlin is no longer supported by the manufacture and most of our existing processors were installed in FY 1988 and FY 1989 and are long past the end of their life cycle and overdue for replacement. The greater capacity of the Legend will allow us to consolidate several Merlin systems into one Legend system and, at the same time, remove the telephone equipment for the GSA utility rooms and locate the Legend in dedicated telecomm wire closets in FOB 3 & 4. We anticipate the Legend will reach the end of its life cycle sometime in 1999 and at that time the current WITS contract for local telephone service will also expire. We will acquire a single, consolidated PBX for the Bureau which will improve service, cut cost and allow the full integration of Vmail/Email. Until a PBX can be acquired, TCO will upgrading all existing Merlin Key systems to Legend Hybrid Key systems. The Northern Telecomm Meridian PBXs located at the Hagerstown Telephone Center (HTC) and the Tucson Telephone Center (TTC) will require software and firmware updates to stay remain current. A PBX for the Jeffersonville Telephone Center (JTC) will provide direct interface to the FTS/PostFTS system and decrease cost while providing a uniform operations platform for all three telephone centers.

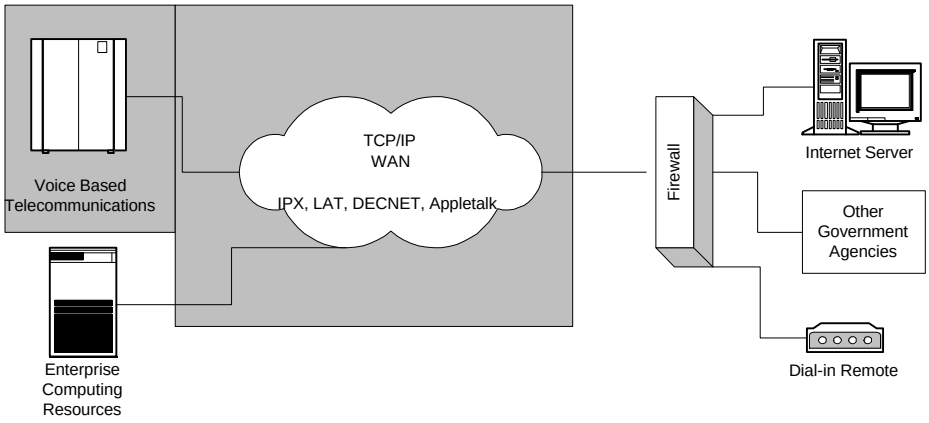
Each of these proposed architecture areas will be defined and related standards referenced in the following sections of Part I. Part II will address the current architecture in detail for each of these architectures and initiatives in process or planned.

Enterprise

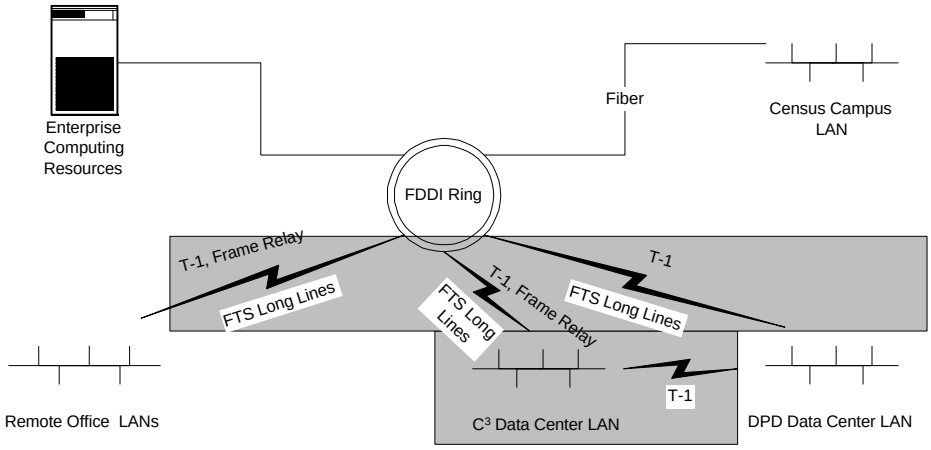
Enterprise Architecture

The Enterprise architecture (see Figure 6) will be based on a fiber backbone using the TCP/IP protocol to link the enterprise resources to the WAN and the external customers. Voice and data

**Enterprise**




**WAN**




**LAN**

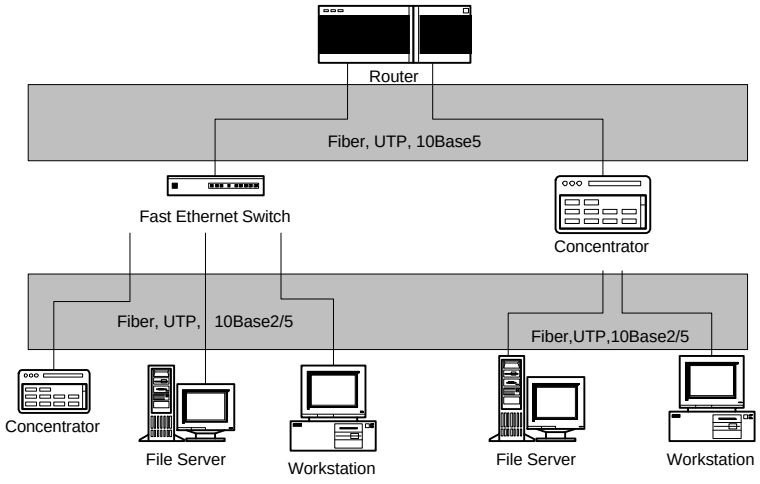


**Figure 3 Current Architecture With Highlighted Transition Areas**

| | CURRENT | TRANSITION | PROPOSED |
|---|---|---|---|
| **PHYSICAL** | | | |
| Cabling | UTP | None | UTP |
| | Fiber | None | Fiber |
| | Thin Coax | UTP, Fiber | UTP, Fiber |
| | Thick Coax | UTP, Fiber | UTP, Fiber |
| Long Haul | T-1 (1.544 Mbps) | T-1 (1.544 Mbps) | T-3 (45 Mbps) |
| Protocol | FDDI | None | FDDI |
| | 10Base2 | 10BaseT | 100BaseT |
| | 10Base5 | 10BaseT | 100BaseT |
| | 10BaseT | 10BaseT, ATM | 100BaseT, ATM |
| | 10BaseF | 10BaseF, ATM | 100BaseF, ATM |
| | Frame Relay | Frame Relay | Frame Relay, ATM |
| Network | TCP/IP | TCP/IP | TCP/IP Enhanced |
| | IPX | TCP/IP | TCP/IP Enhanced |
| | LAT | TCP/IP | TCP/IP Enhanced |
| | DECNET | TCP/IP | TCP/IP Enhanced |
| | AppleTalk | TCP/IP | TCP/IP Enhanced |
| Equipment | Routers | Upgrade Routers | Routers |
| | Concentrators | Upgrade Concentrators | Concentrators |
| | Fast Etherswitches | Concentrators, Fast Etherswitch | Concentrators, Fast Etherswitch |
| Voice | Merlin, Legend | Legend | PBX |
| **MANAGEMENT** | | | |
| Protocol | SNMP | SNMP-2 | SNMP-2 |
| Infrastructure | NOC | None | NOC |
| | No Network Lab | Network Lab | Network Lab |
| | No Central Backup/Archive | Central Backup/Archive | Central Backup/Archive |
| | No Plans/Agreements | Contingency Plans/Agreements | Contingency Plans/Agreements |
| Security | Firewall | Firewall | Firewall |
| | No encryption | Encryption | Encryption |
| Standards | OA Software | OA Software | OA Software |
| | No Video Teleconferencing | Video Teleconferencing | Video Teleconferencing |

**Figure 4 Current Architecture Transitions**

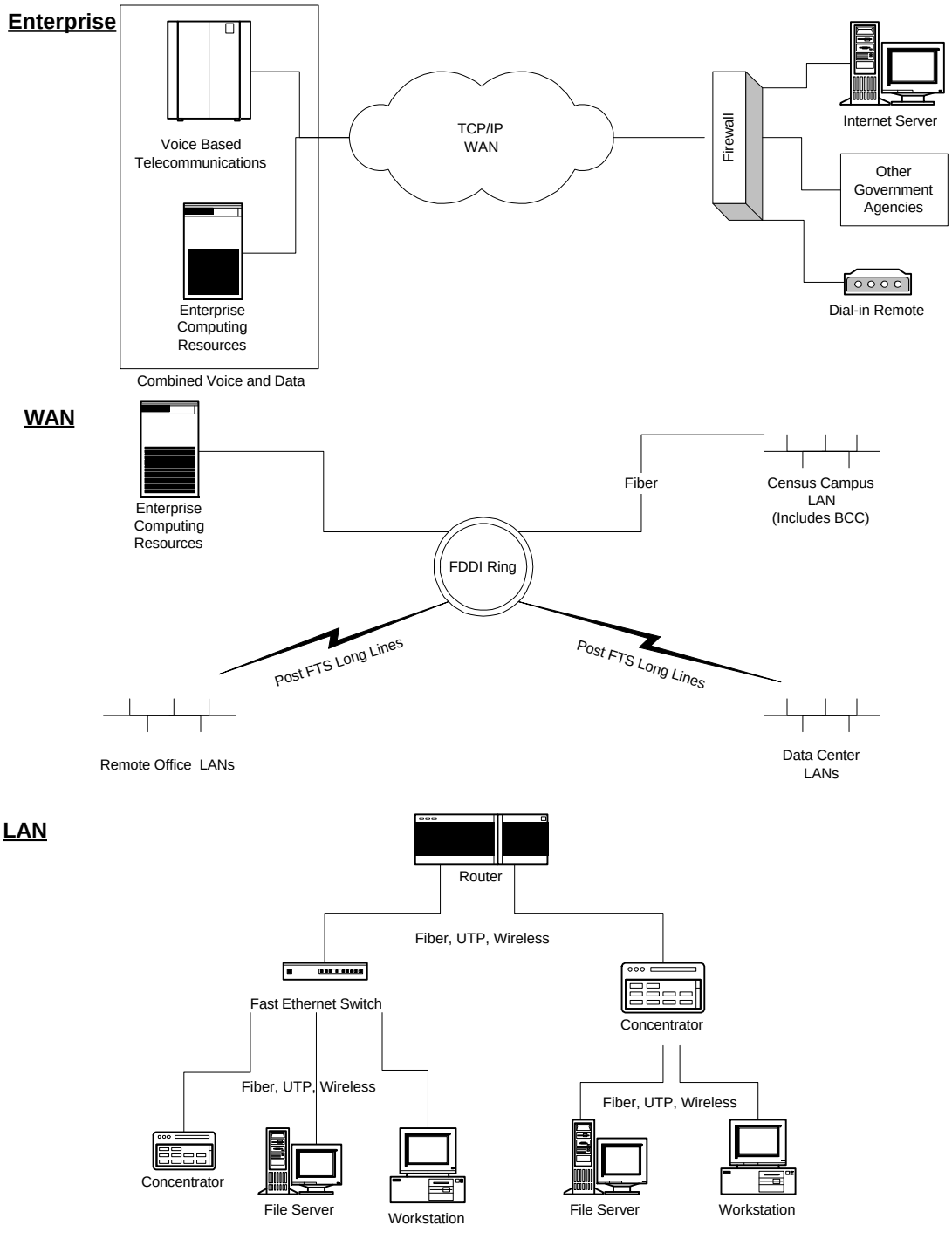



**Figure 5 Planned Architecture**

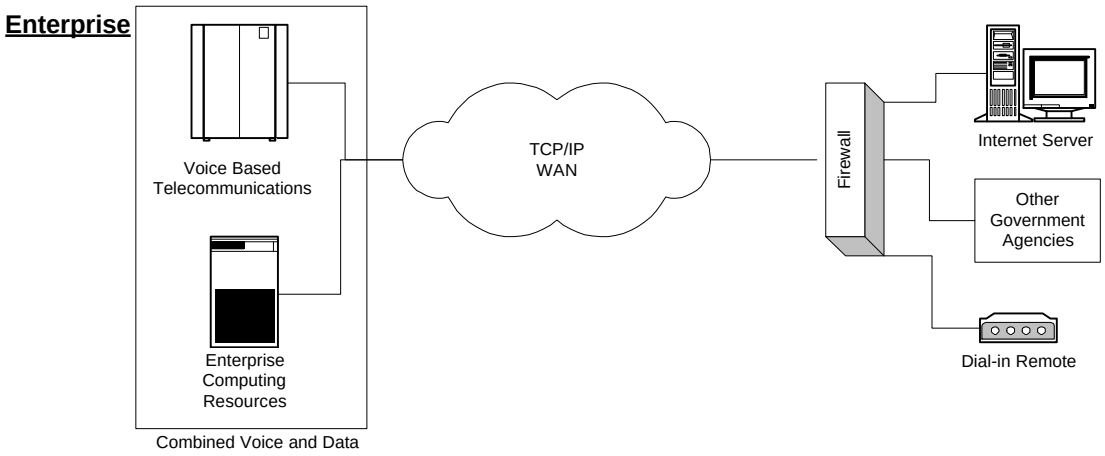



**Figure 6 Planned Enterprise Architecture**

will be combined on the same transport to minimize costs and increase flexibility for voice recognition systems. Use of a fiber backbone will facilitate the anticipated increased data demands on the enterprise computing resources as additional fibers can be activate as the demand increases.

All external users and customers will be provided access through a firewall. The use of a firewall is essential to maintain the data confidentiality as detailed in Section 3 Security. Dial-in access will be restricted to Census employees. Government agencies will be able to access Census data directly depending on the type of data and volume transferred. All other customers will access Census data via the Internet.

In addition, the Enterprise will provide the following services:

- Infrastructure for Directorates and their related programs - To ensure adequate capacity is available for distributed computing.

- Network monitoring - Monitor usage, perform capacity planning, and research new alternatives so that new requirements are anticipated, tested, and installed when the requirement becomes a reality.

- Standard software and support for use within the Enterprise - All software shared across the Enterprise including electronic mail, calendaring, and network.

- Contingency Plans - Alternative operating procedures in case of minor and catastrophic failure.

- Video Teleconferencing - Conferencing capability to the desktop for small groups and to strategically placed video teleconferencing centers for large groups (see user plans).

- Backup/Archive - Provide backup and archive connectivity for all enterprise resources to preserve the integrity of the program data (see SSD plan).

**Infrastructure for Directorates and their related programs**

The Enterprise infrastructure will provide the means to access the Enterprise Computing Resources, which are developed and shared by the various directorate and program offices. This infrastructure is based on the TCP/IP protocol which will allow client server applications to run across the network. While the current Class B address held by Census will not be sufficient to meet the future requirements, the TCP/IP standard is being revised to include an expanded numbering scheme. TCO plans on implementing the expanded TCP/IP standard when it becomes published and products are available.

By providing access to all resources shared by Census, TCO will be able to focus on economies of scale for throughput and performance.

**Network monitoring**

The Enterprise will utilize the Network Operation Center (NOC) to monitor the network for problems, service outages, and performance. This will be accomplished using the Simple Network Management Protocol (SNMP) standard for TCP/IP networks. All enterprise connected equipment, e.g. servers, hubs, routers, etc., will be SNMP-2 compliant. SNMP-2 is the latest (1993) standard for network monitoring and management under a TCP/IP network and extends management capability from the routers, concentrators, and switches to the applications and systems efficiently and securely. The NOC will prepare reports on utilization for TCO review and an annual utilization report. This report will include the number of external customers and government agencies being serviced, throughput rates, bottlenecks, and problems. Problems will be resolved or rerouted and performance will be analyzed for changes. The capabilities of the NOC will increase availability and improve performance.

A laboratory will be set up under the auspices of the NOC, through which TCO will test and evaluate technological innovations and products that are being considered for cost effective implementation in the Census network. This is necessary to assure product functionality, assure network compatibility, and to evaluate potential impacts, good or bad, on network performance and provide cost effective enhancements and technology refreshment to our network.

For critical programs, such as the Decennial Census, the normal NOC operating hours will be expanded to 7 days by 16 hours and 7 days by 24 hours to ensure network availability.

**Contingency Plans**

It is essential that user and customer access not be interrupted. The Enterprise will be responsible for defining and implementing the contingency plan when the need arises. Contingency plans will include:

- Dual lines to remote sites or buildings within a WAN or LAN so that if service is interrupted on a single line, the NOC can reroute the traffic until the line can be restored.

- Hot spares at designated spots so that critical routers or hubs can be brought online while existing equipment is repaired.

- Plans for operations during catastrophic failure, e.g., hurricane, tornado, flood, to address essential processing needs and locations.

**Video Teleconferencing**

Video teleconferencing capability will be provided to the desktop computer for small groups to strategically placed video teleconferencing centers for large groups. Teleconferencing will be investigated and tested in concert with Decennial activities and ongoing surveys in remote offices.

**Backup/Archive**

Provide backup, archive, and restore connectivity for all enterprise resources to preserve the integrity of the data and services provided. This assumes that the backup is from the server to the host machine and restored from same.

**Enterprise Alternatives Considered**

Alternatives considered for the Enterprise architecture included:

- Delegating control and responsibility to the LAN level - This was unacceptable since Census could not obtain the economies of scale or seamless integration that comes with the definition of enterprise standards.

- Outsourcing - TCO will continue to evaluate outsourcing options to implement the planned architecture in the most cost-effective manner.

**Enterprise Benefits**

The benefits of the Enterprise architecture are increased:

- Reliability through the NOC monitoring and problem resolution.
- Scalability through use of fiber backbone, TCP/IP, and standard hardware.
- Functionality by making all enterprise data available to every user.
- Productivity through the use of standard hardware and software, redundant paths, contingency plans, performance criteria, backup.
- Cost effectiveness though the economy of scale on site licenses for standard software and increased productivity.
- Access to Census data to more customers.

It is estimated that the annual cost avoidance to Census amounts to almost $11 million in lost productivity. This is based on a one hour network outage for each Census user in a year. Total savings are $11.3M and include:

- Avoided lost productivity costs by increasing network availability. Based on a one hour outage for 7000 users and using an industry average labor rate per hour of $25.90 (Gartner Group, September 28, 1995), an hour of enterprise availability costs $181,300. By increasing reliability and redundancy to 99.9% uptime from 97%, based on an 8 hour day, 5 days a week, the Bureau can realize savings at almost $11 million (see Figure 7).
- Increased usage of existing resources (already paid for) by providing enterprise data access online.
- Saved $327,000 by purchasing site licenses.

| Hrs/Day | Days/Wk | Uptime | Down Hrs | Cost/Hr | Total Cost | Savings |
|---|---|---|---|---|---|---|
| 8 | 5 | 97% | 62.4 | $ 181,300 | $ 11,313,120 | |
| 8 | 5 | 99.50% | 10.4 | $ 181,300 | $ 1,885,520 | $ 9,427,600 |
| 8 | 5 | 99.90% | 2.08 | $ 181,300 | $ 377,104 | $ 10,936,016 |

**Cost Per Hour Based On:**

| Users | Avg Salary | Load Factor | Avg Comp | Hrs/Yr | Hourly Rate | Total Rate |
|---|---|---|---|---|---|---|
| 7000 | $ 37,000 | 40% | $ 51,800 | 2000 | $ 25.90 | $ 181,300 |

**Figure 7 Enterprise Outage Estimates**

**Enterprise Performance**

The NOC will monitor performance. A baseline will be established for current performance levels in FY 1996 and will be improved upon where needed. In addition, network availability

goals have been established to be achieved as soon as possible. The NOC will monitor and report regularly on the success rate of meeting these goals. These goals include the following:

- Subsecond network response, as perceived by the desktop PC user, to transmissions terminating within the Census LAN.

- Peak period LAN utilization no greater than 40%.

- Network availability to the desktop PC of 99.9%.

- Restore network outages according to a sliding scale based on the total number of users affected by the outage. A desktop shall not be out for more than four hours, if the outage occurs during prime shift hours. Critical outages will be prioritized by the number of users affected and importance of programs.

- Develop user-derived set of standards based on aspects of service that are important to our customers.

**WAN**

**WAN Architecture**

The WAN architecture (see Figure 8) will be based on a fiber backbone with fiber links to the Enterprise Computing Resources and the Census Campus LAN (Washington, DC geographical area). High-speed long lines will be leased from the Post FTS vendor for connectivity to the Remote Office (RO) LANs and the Data Center LANs. The 12 ROs are located strategically across the country. The Data Center is located in Jeffersonville, IN and the CATI sites are located in Hagerstown, MD and Tucson, AZ.

The fiber backbone to connect the routers will be FDDI based at 100 Mbps using the ISO 9314 standard. Additional FDDI rings will be added to accommodate increased traffic requests for Enterprise Computing Resources as the need arises to segment the traffic and keep throughput at the required levels. Backbone utilization will change when network optimization occurs and elements are segmented and additional routers are brought online. This scalability will allow the NOC to monitor the WAN and respond to increased demands before critical levels are reached.

Projected peak utilization is shown as a linear projection of the traffic on the FDDI backbone in Figure 9. Based on actual throughput measurements collected, 892 gigabytes of data traversed the backbone in October 1994 and increased to 1760 gigabytes in October 1995, or a growth rate of 97% per year. Peak utilization, measured as the largest number of bytes sent over a 20 minute period, for October 1995 was 23% of the existing 100 Mbps backbone capacity. Since the backbone must be able to handle the peak loads, TCO used the estimated peak capacity growth rate based on the total throughput growth rate. This does not take into

account major program undertakings like the 1997 Economic Census and the 2000 Decennial Census. TCO plans to increase the capacity of the backbone to meet the projected peak growth when the peak utilization reaches 40%. At the same time, we will provide an architecture that is scalable so that peaks for the major programs can be accommodated within four months of notification of need. Also, we will work with individual user groups to provide for more subnets that will help to localize the traffic away from the backbone. This will provide some opportunities to delay the need for upgrades. Capacity planning through performance monitoring will be a key role of the Network Operation Center.

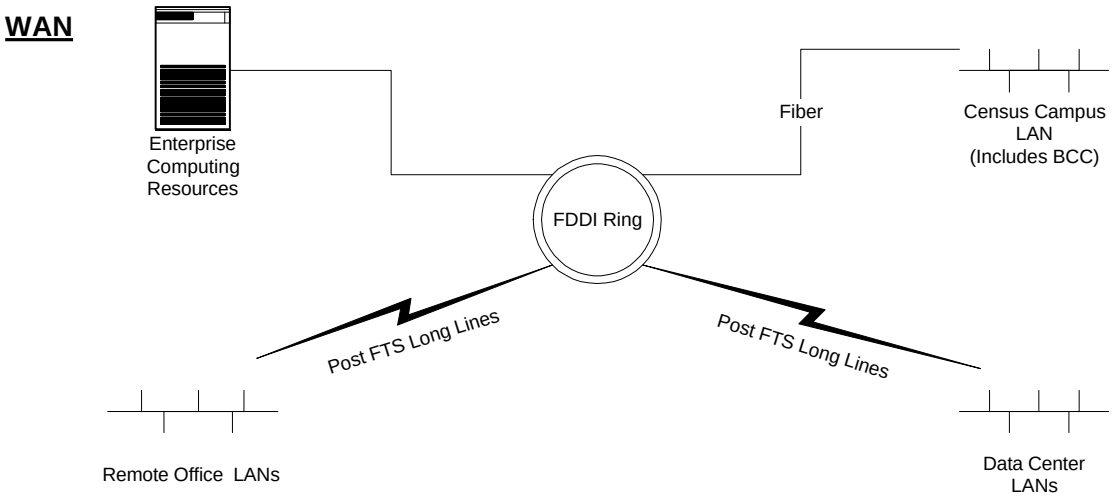



**Figure 8 WAN Architecture**

in place at Census Headquarters, ATM may be used to connect the Census Campus and Data Center LA Based on current projected utilization rates, TCO is evaluating Asynchronous Transfer Mode (ATM) to meet the increased demand. ATM is expected to become integrated onto the fiber backbone as demand requires. The advantage of ATM is that it is one protocol that supports variable bit rates, from 2 Mbps to 155 Mbps and higher. ATM provides a cell relay system that will operate over the Synchronous Optical Network (SONET) at the high end and Frame Relay at the lower end. ATM will allow TCO to increase the capacity of the WAN connection to the LANs as demand requires and still use the same protocol standard. While the FDDI ring will stay Ns.

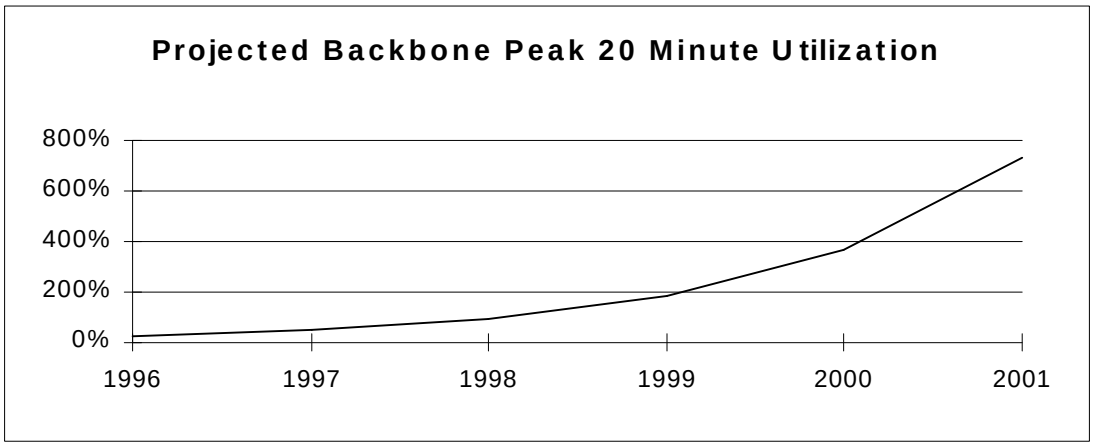



**Figure 9 FDDI Peak Backbone Utilization**

Frame Relay peak utilization on the links to the Remote Offices is shown in Figure 10. Projected utilization is shown as a linear projection of the traffic on the Frame Relay links. Based on actual throughput measurements collected, 14 gigabytes of data traversed the links in January 1995 and increased to 32 gigabytes in January 1996, or a growth rate of 42% per year. Peak utilization, measured as the largest number of bytes sent over a 20 minute period, for January 1996 was 54 Kbps. Since the links must be able to handle the peak loads, TCO used the estimated peak capacity based on the total throughput growth rate. While Frame Relay has up to 2 Mbps transfer rate, it may not handle the projected capacity for the ROs and the Data Centers as multimedia, imaging, and teleconferencing become common. The use of ATM concentrators and routers in the future on these links could increase capacity while capitalizing on the installed base of routers and hubs. The ATM link is anticipated to be utilized on a "band-width as required" basis so that only required capacity is purchased.

The high-speed fiber SONET links will connect the backbone to the Campus LAN to ensure Enterprise Computing Resources placed at the Bowie Computer Center (BCC) will be accessible within the performance criteria specified in the Enterprise Performance Section above. The use of ATM over SONET is planned and requires ATM routers at each end.

All WAN components, e.g. routers and concentrators, will be SNMP-2 compliant so that monitoring and analysis of WAN throughput and problems can be performed. Segment utilization will also be analyzed so that higher cost, higher performance equipment can be located on high demand segments and lower cost, lower performance equipment can be located on lower demand segments.

Multiple data paths on critical links, e.g. SONET links to Bowie Computer Center, will be installed for redundancy and contingency. Load balancing will be performed by the routers and controlled by the NOC using SNMP-2 network management software.

**WAN Alternatives Considered**

Alternative considered included:

- Multiple T-1 leased lines - While Frame Relay over T-1 is currently used, the anticipated capacity requires higher throughput. Leasing a single higher capacity link, e.g. T-3, was more cost effective than leasing multiple T-1s.

- FDDI only - This is an acceptable solution for Headquarters, but does not address the connectivity issues for the geographically dispersed ROs, Data Centers, and the Campus LAN because of the FDDI line length limit of 2000 meters.

**WAN Benefits**

The benefits of the WAN are increased:

- Scalability through the application of additional FDDI rings and ATM links to meet the functionality requirements at the desktop.

- Reliability through multiple and redundant data paths, particularly to critical Enterprise Resources. The network will provide the access when the user needs it.

- Cost effectiveness through a hybrid FDDI, ATM, and Fast Ethernet solution with "band-width as required" that allows the capacity and cost of the segment to be tailored to the demand.

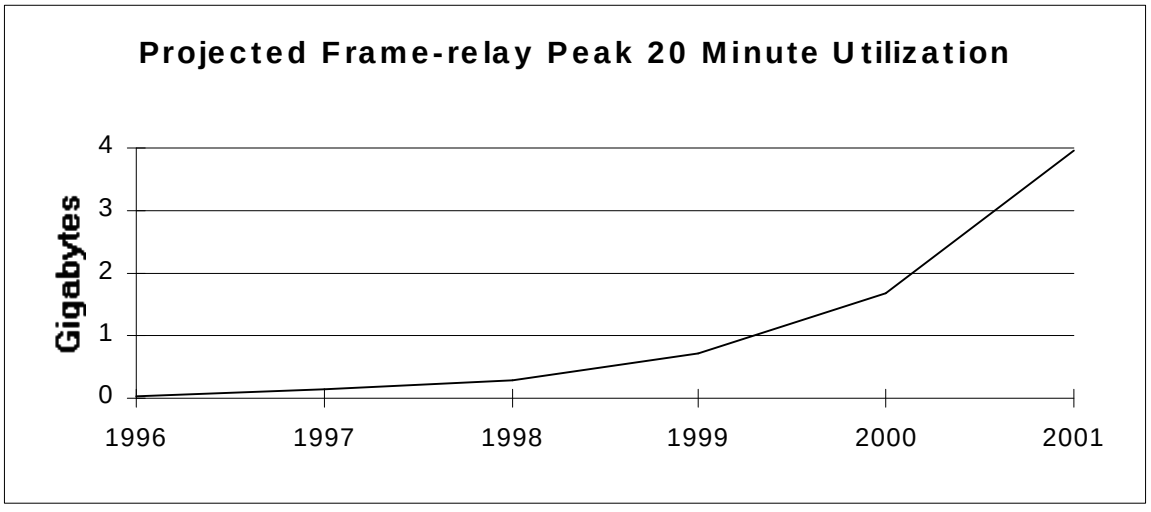



**Figure 10 Frame Relay Utilization**

- Flexibility through the ability to change the location and capacity of the leased lines so that as offices are consolidated, created, or moved, the WAN can provide connectivity with minimal effort.

- Frame Relay is easily increased to meet additional capacity requirements.

The estimated annual cost savings to Census are based on:

- Replacements of long haul dedicated leased lines to 24 Frame Relay links has eliminated single points of failure and removed serious bottlenecks by increasing capacity at the same cost.

- Increased productivity of users based on decreased wait time.

**WAN Performance Measures**

Performance measures are the same as detailed in Enterprise Performance Section above with the addition of:

- Replace or repair of critical components, e.g. routers, within 30 minutes.

- Uptime on leased long lines of 99.9%.

- Capacity utilization of FDDI ring less than 50% on average and less than 80% on any sustained peak of 20 minutes during prime shift.

**LAN**

**LAN Architecture**

The LAN architecture (see Figure 11) will be a 100 Mbps physical star topology with IEEE 802.3 (100BaseX) to connect users in offices located on multiple floors and buildings within a geographical area. There are four basic types of LANs:

- Remote Office - The Remote LAN consists of 80-100 users on a single floor in the same building. This includes CATI sites, Regional Offices, Regional Census Centers, and local collection offices for the Decennial Census.

- Data Center LAN - The Data Center LAN consists of Jeffersonville with 1000-2500 users on single floors within multiple buildings.

- Census Campus LAN - The Census Campus LAN consists of the Washington, DC geographical area and includes Federal Office Building (FOB) 3, FOB 4, Washington

Plaza 1 and 2, SHEP, Iverson Mall, and the Bowie Computer Center. This LAN supports 4000 users.

- Virtual LAN - The virtual LAN is the logical grouping of users into a work group LAN based on functional requirements regardless of where the user is physically located on the LAN, e.g., a given office that has 10 people in FOB 3 and 5 people in Bowie that need to share calendaring, schedules, documents, etc.

The LAN will consist of a router that will connect to the WAN ATM link. Depending on the size and complexity of the LAN, multiple routers will be utilized to provide connectivity from the location of the WAN link to the local segments, e.g. remote buildings. These connections will operate at 100 Mbps or higher depending on the traffic volume being serviced. The links will be fiber, UTP Category 5, or wireless.

From any given router, multiple concentrators and/or fast ethernet switches will be connected. The number of servers, concentrators, and client workstations connected to any given concentrator or switch will depend on the number of users and capacity of the device. Any given device will maintain 10 percent of the available expansion capacity for troubleshooting (bad port) and ad hoc expansion (add another LAN printer or add another user as an office expands). The connection from the concentrator or switch will be fiber, UTP Category 5, or wireless technology.

**LAN**

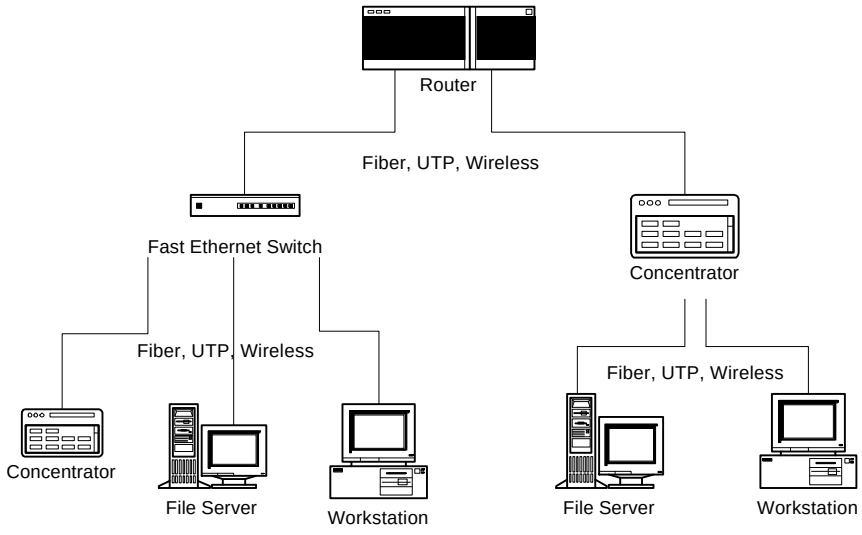



**Figure 11 LAN Architecture**

The potential capacity of a fiber link is almost limitless since it is based on how much light (different wavelengths) can be sent down one or more fibers. The current standards allow 100 Mbps (100BaseFX). The current limits on UTP are 100 Mbps (100BaseT) and wireless standards are still being defined (IEEE 802.11). The target architecture will be fiber between routers, switches, and concentrators and UTP to the desktop. Wireless will be used in connections where an installed cable plant is not available, the installed plant is a lower capacity

than the wireless, or the transient nature of the office makes it not cost effective to install a new cable plant.

The NOC will monitor the utilization of the LAN segments, segment/ resegment the LAN, add additional switches, concentrators, or routers, and perform other configuration activities to maximize the performance of the LAN. The NOC will define the composition and configuration of the Virtual LANs based on program needs.

**LAN Alternatives considered**

LAN Alternatives considered consist of:

- Segmenting - While this is part of the architecture solution, physical grouping of users by itself does not provide the capacity to the user. It has to be used in conjunction with higher speeds and virtual LANs.

- Fast Etherswitches - This as a sole solution was unacceptable because it does not provide the intelligence and functionality of a router.

**LAN Benefits**

The benefits of the LAN are increased:

- Scalability through the addition of routers, concentrators, and switches to meet the functionality requirements at the desktop and the ease of meeting ad hoc requirements.

- Reliability through fault isolation to the port level and management to the port level.

- Cost effectiveness through an installed cable plant that will provide expandable capacity when required.

- Flexibility through the ability to assign users dynamically to virtual LANs for the sharing of data.

**LAN Performance Measures**

Performance measures are the same as detailed in Section 2.1.D with the addition of:

- Replace or repair of critical components, e.g. routers, concentrators, switches, within 30 minutes for the Campus and Data Center LANs.

- Replace or repair of critical components, e.g. routers, concentrators, switches, within 2 hours for the RO LANs.

- Replace or repair Network Interface Cards (NICs) for user connectivity within 2 hours.

**Voice**

**Voice Architecture**

The Voice architecture will be based on a Private Branch Exchange (PBX) inhouse (Census only) telephone switching system that interconnects telephone extensions to each other, as well as to the outside telephone network. It will include functions such as least cost routing for outside calls, call forwarding, conference calling, messaging, and call accounting. The PBX will run over the Enterprise network and will connect all Census users with equal functionality.

The PBX will provide centralized programming, troubleshooting, maintenance, and remote backup and recovery in the event of system failures. PBXs may be located at the Data Centers depending on the volume of traffic and number of users.

This system will provide a voice mailbox for every employee within Census and Voice Mail/E-Mail integration so that a user can check E-mail messages from Voice Mail as well as the reverse. Voice Mail for all Census facilities will bring all employees to the same level of productivity regardless of their location.

**Voice Alternatives considered**

Alternative considered included:

- Continued Merlin/Legend use - The cost of the system increases each year as parts become more difficult to find and system outages cost thousands of manhours a month. The Merlin cannot be terminated to a T-1 so we would have to purchase additional equipment to extend WITS service to non-WITS locations. When the current WITS contract expires, we could negotiate a contract with a local service provider to supply a dial tone. This would be a competitive contract with unknown costs and would result in the Bureau having to change all of its telephone numbers again.

- Continue to use a combination of GSA Consolidated Centrex and Plain Old Telephone Service (POTS) for those areas not currently served by WITS - This means that we will have at least two and possibly as many as four different prefixes and possibly two different area codes for our offices located in Maryland. This is very costly (.10 per call), disruptive, and makes it impossible to provide the full range of voice services to all of our users.

- Continue to provide Centrex dial tone to the Jeffersonville Telephone Center (JTC) - This would create an operational situation that is unique to the JTC and increase training and operational cost significantly. It will also prevent the Bureau from taking advantage of the benefits of volume discounts.

- Continuing upgrade of the PBX's in the Hagerstown Telephone Center (HTC) and the Tuscon Telephone Center (TTC) - Changes in the North American Numbering Plan, the continuing addition of new area codes and the as yet unknown results of the Telecommunications Act of 1996 make this mandatory.

- Provide basic Voice Mail service for our WITS users with no changes - This system, while functional, does not take full advantage of the voice mail capabilities and does not provide the best service to our customers.

**Voice Benefits**

The benefits of the Voice architecture are:

- Current rates on the FTS2000A network are the lowest in the world. We expect that the post FTS network will continue to provide high quality, low cost communications well into the next century.

- When we converted the majority of Census locations to WITS over a year ago, we determined that the cost saving would exceed $600K per year after the first year. The current cost per month for a WITS line is less than half of the cost of a consolidated Centrex and less than one third of the cost for a commercial line. We would save the cost of an off-net call ($.10) every time we place a call from a WITS to a non-WITS location.

- A PBX at Headquarters will allow us to fully integrate our Voice mail/E-MAIL and phone system, and decrease overall costs for voice communications. In addition, the same platform could provide ATM data switching for the LAN/WAN.

- A fully integrated Voice Mail/E-MAIL system will increase user productivity and provide seamless voice/data communications. Voice mail has proven itself as an indispensable tool for the modern office and provides the best service for our customers. All of our offices will have the same voice mail capabilities and will provide a uniform professional appearance to our nationwide customer base.

# 3 Security

**Enterprise Network Security**

**Enterprise Security Architecture**

The enterprise network security architecture provides controlled access to specific areas of the Census network and its resources. Targeted correspondents consist of other Government agencies, foreign governmental statistical agencies, Census Bureau employees connecting from non-Census Bureau offices and the general public. Where once network security was maintained by proscribing all outside access to the Bureau's network, current policy permits public access to all released data. Other authorized personnel are permitted access to the network under closely controlled conditions. Current control is maintained through the use of dedicated circuits to all other governmental agencies using security servers used as isolation firewalls to prevent anyone from gaining direct connection to Census computers. These security servers were once thought to be maximally effective against intruders, but the current literature indicates that hackers have been known to breach these devices.

The architecture is designed around the bastion host concept, which uses a high-speed processor solely to authenticate users, furnishing them a controlled path to the areas of the network to which they have been authorized. The bastion host encompasses additional security measures commensurate with the database being accessed and the openness or vulnerability of the network connection from which the user is accessing the Bureau's network. Traveling employees will call into the network through the Public Switched Telephone Network (PSTN) using a cyber card, which generates a new password every minute in synchronism with the bastion host. The user will be blocked from the network unless the password of the minute is entered correctly. Each cyber card generates unique passwords. These passwords are mathematically related to the cyber card's serial number; thus, it is possible to positively identify the user and to block access to lost or unissued cyber cards.

Another class of employee accesses the Bureau's network over the PSTN - the field representatives. They call in via a toll-free line during the night hours. They are blocked from the main network through a security server based firewall. The security on this network will be file encryption.

**Enterprise Security Alternatives**

Alternatives considered include:

- Continue at the level of security currently in place - To maximize the response to our surveys and censuses, the public's perception of the sanctity of their personal information must be absolute. Any report or rumor that the Bureau's network has been breached will reduce the response rate and drive the cost of acquiring the withheld data several orders of magnitude beyond the cost of protection. There are realistic threats of hackers breaking into networks for the intellectual accomplishment or for the simple conquest. We would be remiss if we knowingly continued to rely on the weak protection offered by our current system.

- Limit PSTN access to the network.- Not only is facile public access to authorized data a fine gesture in keeping with the administration's desires to provide easy access to the

Government's records, but the operational efficiencies afforded the Bureau by receiving daily transmissions of survey results and of maintaining contact while on travel outweigh the cost of protecting against the threats that come with these benefits.

**Enterprise Security Benefits**

The benefits of the Security architecture are:

- The benefits of accessibility to the network itself, such as, reduction in survey data capture and quality control times and efforts, providing travelers with access to mail and work.
- Remote access to network management and control information for quick diagnosis of network problems.
- Providing the public with access to survey reports more easily and more timely and the streamlining of data collection activities from businesses.
- Cost avoidance from additional data collection expenditures which would occur if the public were alarmed that their personal data might be compromised.

**Enterprise Security Performance Measures**

The performance of the security measures will not degrade performance of or limit the access to the Enterprise network.

**WAN**

**WAN Security Architecture**

Where necessary, TCO will encrypt sensitive data traversing the WAN. Encryption will be applied directly on the WAN if it is not feasible to do so at the file or LAN level, either of which is preferable.

**WAN Security Alternatives**

Alternatives considered are LAN encryption.

**WAN Security Benefits**

The benefits are the same as the Enterprise Security Benefits.

**WAN Security Performance Measures**

The performance requirements are the same as the Enterprise performance measures.

**LAN**

**LAN Security Architecture**

The architecture of the LAN's security is determined by weighing the network access required by the users against the degree of protection required. The degree of security needed is not ours alone to decide. Because we are now enjoying the expediency of receiving data from other Government agencies, we are required to conform to their special internal security regulations. We must comply, because it would be very expensive to collect the data a second time. This also conforms to organizational policy of using administrative records to supplement or reduce direct data collection activities. In addition to using the bastion host to control access, we will encrypt all of their data that leave our facility over copper wires, which can be compromised (fiber lines are much harder to compromise). In order to get the data to the WAN, they must traverse the LAN. To maintain absolute control over the data, they should be encrypted while they are still on the LAN.

**LAN Security Alternatives**

Several new encryption techniques have been developed:

- Encrypting the file;
- Encryption on the fly over the LAN;
- Encryption on the leased long lines.

LAN encryption can be done in bulk, or selectively by protocol. Each alternative will be investigated for ease of use, effectiveness, impact on both the network and the processing load and cost to implement and operate.

**LAN Security Benefits**

The benefits are the same as the Enterprise Security Benefits.

**LAN Security Performance Measures**

The performance requirements are the same as the Enterprise performance measures.

**Other Security Considerations**

Title 13 of the United States Code requires that we prevent unauthorized access to or release of information about persons or businesses. Any change we make will incorporate a vulnerability study of the proposed system. We will include the cost of measures employed to counter these threats as part of the total system cost. Of particular concern is developing a security plan and

vulnerability study of the University of Maryland's access to our Bowie Computer Center. The success of this venture is contingent on precluding any threat to Title 13 confidentiality.

Privacy and security are maintained in accordance with provisions of: Title 13, United States Code; the Bureau of the Census Administrative Manual; applicable sections of the DOC Handbook of Security Regulations and Procedures; Security Office reviews of systems and directives from the Security office.